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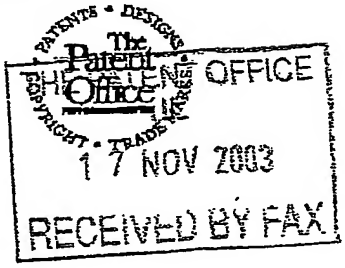

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P01/7700 0.00-0326707.7

Request for grant of a patent

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Cardiff Road
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1. Your reference — M03B335/ASB

2. Patent application number *(The Patent Office will fill in this part)* — 0326707.7

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

The BOC Group plc, Chertsey Road, Windlesham, Surrey, GU20 6HJ

Patents ADP number *(if you know it)* — 884627002 ✓

If the applicant is a corporate body, give the country/state of its incorporation — England

4. Title of the invention — EXHAUST GAS TREATMENT

5. Name of your agent *(if you have one)* — Andrew Steven BOOTH

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

The BOC Group plc, Chertsey Road, Windlesham, Surrey, GU20 6HJ

Patents ADP number *(if you know it)* — 884627002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicants named in part 3 is not an inventor, or

b) there is an inventor who is not named as an applicant, or

c) any named applicant is a corporate body.

See note (d))

Yes

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9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation sheets of this form	0
Description	8
Claim(s)	3
Abstract	1
Drawing(s)	1

10. If you are also filing any of the following, state how many against each item.

Priority documents	0
Translations of priority documents	0
Statement of inventorship and right to grant of a patent (Patents Form 7/77)	0
Request for a preliminary examination and search (Patents Form 9/77)	1
Request for a substantive examination (Patents Form 10/77)	0
Any other documents (please specify)	0

11. I/We request the grant of a patent on the basis of this application.

Signature(s) Date 17/11/2003

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom

Andrew Steven Booth
(01276) 807612

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DUPLICATE

M03B335/ASB

EXHAUST GAS TREATMENT

The present invention relates to apparatus for and a method of preventing pipe work from becoming blocked. The invention finds particular application in reducing clogging of the inlet of a wet scrubber used in the semiconductor industry.

Many semiconductor processes use or generate solid, condensable or subliming compounds. For example, low-pressure chemical vapour deposition silicon nitride (LPCVD nitride) processes tend use chlorosilanes (such as dichlorosilane or trichlorosilane) and ammonia to produce a uniform layer of silicon nitride to insulate the substrate. These processes tend to produce a very thick film of silicon nitride, and consequently require very long deposition cycles, typically 3 to 8 hours. As a result, a lot of powder is generated as a by-product of this process. Such by-products include complex ammonium-chloro-silicate salts, for example, ammonium hexachlorosilicate, which sublimes at 120 °C at atmospheric pressure.

As these materials enter the inlet of a wet scrubber they cool, and can agglomerate and react with water vapour back streaming from the wet scrubber. For example, ammonium hexachlorosilicate can form a glass like deposit lining the inlet of the wet scrubber. If deposit build-up is allowed to continue uninterrupted, it can completely block the inlet, incurring down time and loss of production. For instance, most process tool manufacturers (OEMs) mechanically clean the process chamber off-line, which allows the solid deposits to build up uninterrupted.

It is an aim of at least the preferred embodiment of the present invention to seek to solve these and other problems.

In a first aspect, the present invention provides apparatus for reducing clogging of an inlet pipe to a wet scrubber, the apparatus comprising a body having an open end adapted to be detachably connected about an aperture of the inlet pipe, a shaft moveable within and relative to the body, a scraping device attached to one end of the shaft, means for reciprocally moving the shaft to urge the scraping

device into the inlet pipe to dislodge particulates deposited within the pipe and to withdraw the scraping device from the inlet pipe, and, extending about the body, means for injecting one or more streams of heated, compressed gas into the body to inhibit particulate deposition therein.

Thus, the invention can ensure that the piped interface between the exhaust of the process tool and the inlet to the wet scrubber remains substantially free from obstruction. This can increase the availability of the process tool, reducing maintenance and operating costs.

Introducing into the body a hot gas purge at a temperature preferably in the range from 50 to 200°C, most preferably in the range from 80 to 120°C, can increase the partial pressure of the water vapour back- streaming from the wet scrubber, thereby reducing the risk of condensation within the body. This is because any condensed water vapour would form a cold spot and promote the deposition of materials within the body.

In principle, any compressed gas may be used. Two commonly available gases are clean dry air (CDA) and nitrogen. Nitrogen is preferred because it will not react with the chemical species typically present in the inlet pipe, unlike the oxygen present in CDA; oxygen will react with silicon hydrides to form solid deposits, for example silane, di-chloro-silane and tri-chloro-silane.

Preferably, the injecting means comprises a plurality of orifices spaced around the inner surface of the body for directing the gas against the shaft. By injecting the purge gas circumferentially around the body, the risk of forming eddy currents can be minimised; such eddy currents can promote solid formation. Furthermore, the outer surface of the retracted scraping device can be kept hot and dry, and at

within the range from 80 to 150°C. This can also assist in preventing a "cold" finger from entering the body and accelerating the rate of deposition.

The mechanical scraper may be, in principle, any mechanical device that touches the walls of the pipe as it is moved therein. However, if the scraper was rigid, tough deposits could deform the scraper and damage the shaft. Therefore, a preferred embodiment is a helical coil, due to its innate flexibility and multiple surfaces for removing tough deposits. The coil may take any convenient form, although the greater the number of coils passing any one section, the higher the removal efficiency. For instance, the preferred embodiment uses a helical coil with a pitch of around 18mm, and a length of over 110 mm. The scraping device is preferably formed from a chemically inert and mechanically stable solid material, such as stainless steel.

Preferably, the moving means comprises a pneumatic cylinder attached to the other end of the body. A variety of pneumatic cylinders are commercially available (for example, single or dual acting, with or without spring return, with fixed or rotating shaft), all of which could be used. A preferred embodiment uses a double acting, rotating shaft, magnetic piston, with cushioned end stops. Benefits of the double acting actuator without a spring return are that it can be driven into the retracted position and can easily overcome the forces exerted on the scraper by the incoming process gases, there is no loss of force during extension or retraction, and the rotating shaft enables the helical coil to cut through very hard deposits.

The magnetic piston enables position indicators, such as reed switches, to validate the cylinder's position (extended or retracted), and feed this information back to the control system to ensure that the apparatus is performing optimally.

Providing pneumatically cushioned end stops can prevent damage to the ends of the actuator shaft. The actuator shaft should have sufficient mechanical strength to prevent bowing or other mechanical damage. In the preferred embodiment, a

solid 12mm diameter stainless steel shaft is used, although in principle the shaft may be formed from any convenient size or material.

In the preferred embodiment, the actuator stroke is sufficient to clean the end of the inlet without the end of the scraper becoming wetted by scrubber liquid, and to fully retract the scraping device from the gas stream passing through the inlet pipe. Thus, the scraping device is preferably at least partially, most preferably substantially contained within the body when the shaft is in a fully retracted position. If the scraper were left in the gas stream it could act as a catalyst to pipe blockage. For example, strokes of 120 and 250mm are used in different embodiments of the invention.

Pneumatic pressure selection is another important factor. The actuator should supply sufficient force to remove hard and stubborn deposits without damaging other delicate components. Theoretically any positive pressure is acceptable, for example 0 - 10 bar gauge, although in practice 2 - 4 bar gauge has been found to be sufficient.

During normal operation, solid material can build up on the actuator shaft as the scraper is moved into the (cooler) inlet pipe. The apparatus therefore preferably comprises means for preventing particulates deposited on the shaft from being drawn into the moving means as the shaft is withdrawn from the inlet pipe. For example, the apparatus may comprise scraping means, such as an annular seal through which the shaft passes, for scraping particulates from the shaft during movement thereof. Without an additional scraper seal these deposits could be dragged back through actuator nose seal. In principle any seal material could be used; to date we have found PEEK™ (poly-ether-ether-ketone) to be the most efficient material for minimising shaft abrasion while [illegible] the sleeves

an aperture of the inlet pipe an attachment comprising a body, a shaft moveable within and relative to the body, and a scraping device attached to one end of the shaft; reciprocally moving the shaft to urge the scraping device into the inlet pipe to dislodge particulates deposited within the pipe and to withdraw the scraping device from the inlet pipe; and injecting one or more streams of heated, compressed gas into the body to inhibit particulate deposition therein.

Preferred features of the present invention will now be described with reference to the accompanying drawing, which illustrates a cross-section through an example of an apparatus for reducing clogging of an inlet pipe to a wet scrubber.

As illustrated in the drawing, the apparatus is in the form of an attachment 10 to a flanged end 12 of a pipe inlet 14 to a wet scrubber. The attachment 10 comprises a sleeve 16 having a flanged open end 18 detachably connectable by any suitable means, such as bolts or the like, to the flanged end 12 of the pipe 14. The wet scrubber inlet 17 is formed from plastics material which has higher thermal stability in the range from 80 to 250°C, most preferably in the range from 120 to 170°C. Suitable materials include, but are not limited to, polypropylene, polytetrafluorethylene, polysulphone, polyethersulphone, polyetherimide and polyvinyl difluoride. A heater 20 extends about the outside of the sleeve 16 to maintain the temperature within the sleeve 16, in use, within the range from 50 to 200°C, preferably within the range from 80 to 150°C.

A Swagelock™ capped fitting 22 is provided at the other end of the sleeve 16. A hot, compressed purge gas, such as nitrogen or clean dry air, is injected at a rate of 2 to 10 slpm from a source thereof (not shown) into the fitting 22 through nozzle 24. The gas is injected at a temperature in the range of 50 to 200°C, preferably in the range from 80 to 120°C.

Creating a hot, dry inert environment within the sleeve can minimise the likelihood of particulate deposition within the sleeve. Gas injection also increases the partial pressure of any water vapour back-streaming from the wet scrubber, thereby

reducing the risk of condensation within the sleeve and also preventing deposition of particulates within the sleeve.

The nozzle 24 is in fluid communication with an annular channel 26 within the fitting 22, the channel 26, in use, supplying gas to a number of orifices formed on the inside of the fitting 22 for directing gas into the sleeve 16. In the preferred embodiment, the fitting 22 has four orifices 28 spaced circumferentially about the inside of the fitting 22, although any suitable number (that is, one or more) of orifices may be provided as required.

The fitting 22 includes a central bore 30 through which passes a moveable, stainless steel actuator shaft 32, the orifices 28 being arranged to direct the injected hot, compressed purge gas on to the surface of the shaft 32. An annular PEEK™ scaper seal 33 is provided within the bore 30 to scrape particulates from the surface of the (moving) actuator shaft 32. Attached to the free end 34 of the shaft 32, that is, the end normally located within the sleeve 16, is a scraper 36 in the form of a stainless steel helical coil. A pneumatic cylinder 40 is provided for moving the actuator shaft 32 relative to the sleeve 16. Reed switches 42 validate the cylinder's position, and feed this information back to a control system (not shown).

In use, the control system operates the pneumatic cylinder 40 to reciprocally move the shaft 32 to urge the coil 36 into the inlet pipe 14 to dislodge particulates deposited within the inlet pipe 14 and to withdraw the coil from the inlet pipe 14 back into the sleeve 16, away from process gases, indicated at 44, flowing from a process tool into the inlet pipe 14. The attachment can be operated either at a regular "pre-programmed" timer (ranging from every 30 seconds to a weekly event, optimum every 5 hours) or from a remote trigger. The [illegible]

This can be eliminated if the mechanical clean only happens when the process tool is idle.

Pneumatic valves may control the actuator operation. Multiple configurations are available. The apparatus can use either one off, five two or two off, three two valves.

In summary, an attachment for an inlet pipe to a wet scrubber or other abatement device comprises a sleeve having an open end adapted to be detachably connected to a flanged end of the inlet pipe. A shaft is moveable within the sleeve, and a scraper is attached to one end of the shaft. A pneumatic cylinder attached to the other end of the sleeve reciprocally moves the shaft to urge the scraper through the open end of the sleeve into the inlet pipe to dislodge particulates deposited within the pipe and to withdraw the scraper from the inlet pipe. One or more streams of heated gas such as nitrogen or dry air are injected into the sleeve to prevent scrubbing liquid from condensing within the sleeve and thus prevent particulates from being deposited therein.

Although the invention has been described with reference to its use in cleaning an interior surface of a pipe inlet to a wet scrubber, it can be used to clean any suitable surface in an abatement device or other system which is prone to particulates being undesirably deposited by a process gas.

In addition to semiconductor processing systems, the device can be used as part of other types of chemical processing systems in which there are surfaces prone to chemical particulates being deposited by a process gas.

In connection with the wet scrubber inlet 17, semiconductor metal etch processes can produce aluminium chloride as a by-product. Aluminium chloride itself reacts very rapidly with water to produce a solid by-product (aluminium oxide(s)) and an acid gas (hydrogen chloride). Controlling the interface between wet and dry is critical to prevent solid build-up and liquid acids. The concentrated acidic

solutions, in time, will corrode any metal pipe work resulting in loss of production and an increase in overheads. Again, a hot gas purge will prevent the water vapour condensing and liquid pools from forming.

Polyvinyl chloride (PVC) has been the material of choice for wet scrubber inlets, because of its chemical, machining and welding properties. Unfortunately, PVC mechanical strength seriously deteriorates above 60 °C. With the introduction of heaters to raise the gas temperature above 60 °C, manufactures have had to add cooling circuits to reduce the inlet temperature. This increases the machining and operating costs. In a single fault condition, loss of cooling will thermally stress and damage the inlet. This can result in the machine being forced to shut down which in turn increases the operating cost of the unit.

Using plastics with higher thermal stability (melting points), typically in the range from 80 to 250°C, preferably in the range from 120 to 170°C, removes the need for this cooling channel and enables the inlet to function at significantly higher temperatures, reducing the rate of deposition and increasing the time between maintenances. For example, the body may be formed from one of polypropylene, polytetrafluorethylene, polysulphone, polyethersulphone, polyetherimide and polyvinyl difluoride.

CLAIMS

1. Apparatus for reducing clogging of an inlet pipe to a wet scrubber, the apparatus comprising a body having an open end adapted to be detachably connected to an aperture of the inlet pipe, a shaft moveable within and relative to the body, a scraping device attached to one end of the shaft, means for reciprocally moving the shaft to urge the scraping device into the inlet pipe to dislodge particulates deposited within the pipe and to withdraw the scraping device from the inlet pipe, and, extending about the body, means for injecting one or more streams of heated, compressed gas into the body to inhibit particulate deposition therein.

2. Apparatus according to Claim 1, wherein the injecting means comprises a plurality of orifices spaced around the inner surface of the body.

3. Apparatus according to Claim 2, wherein the orifices are arranged to direct the gas against the shaft.

4. Apparatus according to any preceding claim, comprising means for heating the gas to a temperature within the range from 50 to 200°C, preferably within the range from 80 to 150°C.

5. Apparatus according to any preceding claim, wherein said gas comprises dry air or nitrogen.

6. Apparatus according to any preceding claim, comprising heating means extending about the body for maintaining the temperature thereat within the range from 50 to 200°C, preferably within the range from 80 to 150°C.

7. Apparatus according to any preceding claim, wherein the scraping device has an open construction.

8. Apparatus according to any preceding claim, wherein the scraping device comprises a helical coil.

9. Apparatus according to any preceding claim, wherein the scraping device is formed from a chemically inert and mechanically stable solid material, such as stainless steel.

10. Apparatus according to any preceding claim, wherein the moving means comprises a pneumatic cylinder attached to the other end of the body.

11. Apparatus according to any preceding claim, wherein the moving means is arranged to rotate the shaft to thereby rotate the scraping device within the inlet pipe.

12. Apparatus according to any preceding claim, wherein, when fully withdrawn from the inlet pipe, the scraping device is substantially contained within the body so as not to be exposed to gases within the inlet pipe.

13. Apparatus according to any preceding claim, comprising means for preventing particulates from being drawn into the moving means as the shaft is withdrawn from the inlet pipe.

15. Apparatus according to Claim 14, wherein the scraping means comprises an annular seal through which the rod passes.

16. A method of reducing clogging of an inlet pipe to a wet scrubber, the method comprising detachably connecting to an aperture of the inlet pipe an attachment comprising a body, a shaft moveable within and relative to the body, and a scraping device attached to one end of the shaft; reciprocally moving the shaft to urge the scraping device into the inlet pipe to dislodge particulates deposited within the pipe and to withdraw the scraping device from the inlet pipe; and injecting one or more streams of heated, compressed gas into the body to inhibit particulate deposition therein.

ABSTRACT

An attachment for an inlet pipe to a wet scrubber or other abatement device comprises a sleeve having an open end adapted to be detachably connected to a flanged end of the inlet pipe. A shaft is moveable within the sleeve, and a scraper is attached to one end of the shaft. A pneumatic cylinder attached to the other end of the sleeve reciprocally moves the shaft to urge the scraper through the open end of the sleeve into the inlet pipe to dislodge particulates deposited within the pipe and to withdraw the scraper from the inlet pipe. One or more streams of heated gas such as nitrogen or dry air are injected into the sleeve to prevent scrubbing liquid from condensing within the sleeve and thus inhibit particulate deposition therein.

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